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STRAIN RATE-DEPENDENT DEFORMATION IN BULK METALLIC GLASSES

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The structure of metallic glass is metastable. As a result, their plastic deformation is dependent upon structural kinetics. In the present paper, we present data obtained from Zr and Pd-base metallic glasses and discuss the kinetic aspects of plastic deformation, including both heterogeneous and homogeneous deformation. In the case of homogeneous deformation, typically occurring in the supercooled liquid region, Newtonian behavior is not universally observed. In fact, Newtonian flow usually takes place only at low strain rates. In contrast, at high strain rates, non-Newtonian behavior is usually observed. It is demonstrated that this non-Newtonian behavior is associated with *in situ* crystallization of the amorphous structure. In the case of heterogeneous deformation (occurring at room temperature), the deformation is controlled by localized shear banding. The plastic deformation of Pd-base and Zr-base metallic glasses has been investigated using instrumented nanoindentation experiments over a broad range of indentation strain rates. At low rates, the load-displacement curves during indentation exhibit numerous serrations or pop-ins, but these serrations become less prominent as the indentation rate is increased. Using the tip velocity during pop-in as a gauge of serration activity, we find that serrated flow is only significant at indentation strain rates below certain critical values. This critical strain rate appears to be alloy dependent. For example, it is observed to be higher in Pd-base than Zr-base alloys. This result suggests a transition in plastic flow behavior at high strain rates, in agreement with prior studies of bulk metallic glasses under different modes of loading.

STRUCTURAL BULK METALLIC GLASSES WITH VARIOUS LENGTHSCALE OF CONSTITUENT PHASES

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The recent development of multicomponent bulk metallic glasses with secondary phases ('structural bulk metallic glasses' or 'metallic glass composites') opens interesting perspectives for applications as advanced structural and functional materials. This contribution presents results for Zr-base and Mg-base composite materials with different lengthscale, morphology and volume fraction of secondary phases. The materials are either produced as in-situ composites directly upon slow cooling from the melt, by partial crystallization or by blending of glassy powders with pure metals or dispersoids. For cast specimens, the effect of stoichiometry and cooling conditions on phase formation will be described for Zr-Ti-Nb-Cu-Ni-Al alloys, showing that both strongly affect the phase selection and the resulting dendritic morphology upon casting. Whereas casting leads to composites with ductile secondary phases with a lengthscale of up to several microns, partial crystallization or powder metallurgy yields secondary phases with a typical lengthscale on the order of several nanometers. This will be discussed with respect to the underlying thermodynamics and kinetics of nucleation and growth processes upon solidification from the melt in contrast to the conditions governing solid state reaction and annealing. For the different types of materials selected examples for the thermal stability against transformation or grain growth and the viscosity of the supercooled liquid will be given. Furthermore, it will be shown that the different size of secondary phases strongly affects the resulting room temperature mechanical properties.

PREPARATION OF BULK Zr55Al10Ni5Cu30 METALLIC GLASS RING BY CENTRIFUGAL CASTING

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Based on the principle of centrifugal force and taking into account the high glass-forming ability (GFA) of Zr-based alloys, the conventional centrifugal casting method to produce the bulk amorphous rings was used. The fully amorphous ring with a thickness of 1 mm of the $Zr_{55}Al_{10}Ni_5Cu_{30}$ alloy has been successfully prepared by the conventional centrifugal casting method. For the rings with a thickness of 1.5 and 2 mm, some Zr_2Cu and Zr_2Ni phases precipitated from the amorphous matrix. Centrifugal casting method is an important process for the extension of application field of amorphous alloy, such as the preparation of amorphous tube and gradient amorphous matrix composites.

SUPERPLASTICITY IN A BULK AMORPHOUS Pd-40Ni-20P ALLOY: A COMPRESSION STUDY

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Recent advances in metallic glasses that have high glass-forming ability and high thermal stability have initiated a great number of studies for fundamental investigations and practical uses. In the present study, compressive deformation behavior of a bulk amorphous Pd-40Ni-20P alloy has been characterized in the supercooled liquid region. Significant reductions in sample height (>95%) were achieved after deformation, suggesting the possible superplastic-like behavior in the alloy. Structures of the amorphous material, both before and after deformation, were examined using X-ray diffraction and Transmission electron microscopy. Superplastic-like compressive properties will be presented and discussed in light of the microstructure/crystal structure results.